

Appendix O. Sample Measures Pertinent to Broadly Applicable Vital Signs

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15 August 2003

Table 1. Sample measures of vital signs that are broadly applicable across parks of the Northern Colorado Plateau Network. Narrowly applicable, park-specific vital signs (e.g., pertaining to particular at-risk species or unique ecosystems such as caves) are not included in this table. Table 5 and park-specific vital-signs tables (in main body of Phase II Report) indicate actual vital signs identified for each park. Measures used to monitor particular vital signs may vary both among and within individual parks depending on site- and scale-specific considerations.

Vital-sign category	VITAL SIGNS	Sample measures (measures vary in degree of specificity; those with potential applicability to multiple vital signs are indicated in bold type)
Ecosystem characteristics		
Climatic conditions	Precipitation patterns	Total daily precipitation
		Frequency, magnitude, and duration of precipitation events
		Form of precipitation (rain vs. snow)
	Air temperature patterns	Daily minimum and maximum air temperatures
	Wind patterns	Average wind velocity and direction
		Frequency, magnitude, duration, and directionality of wind events
Air quality	Atmospheric deposition	Nitrogen deposition
		Sulfur deposition
		Major cation & anion deposition
	Visibility	Atmospheric particulate concentrations
		Visual range
		Light extinction
		Deciview
	Tropospheric ozone levels	Atmospheric ozone concentrations
		Foliar characteristics of ozone-sensitive plants
		Physiological performance of ozone-sensitive plants

Table 1 continued.

Vital-sign category	VITAL SIGNS	Sample measures (measures vary in degree of specificity; those with potential applicability to multiple vital signs are indicated in bold type)
Ecosystem characteristics		
Soil, water & nutrient dynamics	Upland soil / site stability	Spatial distribution & density of social trails
		Spatial distribution & density of trailing by large ungulates
		Spatial distribution & density of vehicular disturbances
		Spatial extent of soil disturbances associated with trailheads, campgrounds, and other high-use areas
		Number, spatial distribution, and spatial extent of backcountry campsites
		Cover of biological soil crusts by morphological group
		Cover and structure of live vegetation
		Soil aggregate stability (field index)
		Litter and rock cover
		Size of bare-ground patches
		Soil-surface height in relation to benchmark
		Soil accumulation behind silt fences or natural sediment traps
		Soil accumulation in dust traps
	Upland hydrologic function	Soil penetration resistance (compaction measure)
		Spatial distribution & density of social trails
		Spatial distribution & density of trailing by large ungulates
		Spatial distribution & density of vehicular disturbances
		Spatial extent of soil disturbances associated with trailheads, campgrounds, and other high-use areas
		Number, spatial distribution, and spatial extent of backcountry campsites
		Cover of biological soil crusts by morphological group
		Cover and structure of live vegetation
		Soil aggregate stability (field index)
		Litter and rock cover
		Size of bare-ground patches
		Soil-surface height in relation to benchmark
		Soil accumulation behind silt fences or natural sediment traps
		Cover of biological soil crusts by morphological group
	Nutrient cycling	Litter cover
		Size of bare-ground patches
		Cover of live vegetation
		Soil penetration resistance (compaction measure)
	Stream flow regime	Continuous stream flow / discharge (cfs or cms); stream hydrograph characteristics (e.g., flow duration curves)
		Number and duration of dry periods in streams and rivers
		Frequency and duration of flow in ephemeral and intermittent channels

Table 1 continued.

Vital-sign category	VITAL SIGNS	Sample measures (measures vary in degree of specificity; those with potential applicability to multiple vital signs are indicated in bold type)
Ecosystem characteristics		
Soil, water & nutrient dynamics	Stream / wetland hydrologic function	Areal extent of riparian / wetland vegetation
		Composition, structure, and vigor of riparian / wetland plant communities
		Stream channel morphology – surveyed cross sections
		Spatial distribution and size of sediment deposits / sandy beaches along major rivers
		Stream sediment load
		Spatial distribution & density of social trails in riparian / wetland zones
		Spatial distribution & density of trailing by large ungulates in riparian / wetland zones
		Spatial distribution & density of vehicular disturbances in riparian / wetland zones
		Soil penetration resistance (compaction measure) in riparian / wetland zones
	Groundwater dynamics	Water quantity (flow / discharge) at seeps, springs, hanging gardens
		Areal extent of wet soil / substrate associated with seeps, springs, hanging gardens
		Water-table elevation in relation to ground-surface elevations along ephemeral stream reaches
		Groundwater depth in wells pertinent to park groundwater recharge (small, regional aquifers)
		Areal extent of groundwater-dependent vegetation
		Composition, structure, vigor of groundwater-dependent plant communities
Water quality	SEE WATER QUALITY SECTION	
Disturbance regimes	Fire regimes	Fire occurrence on park lands – frequency, spatial distribution / extent, intensity, and timing
		Fire management activities on park lands – spatial distribution and timing by type of activity
		Spatial distribution and relative proportion of park lands in different “fire regime current-condition classes”
		Spatial distribution / continuity and proportional cover of fine surface fuels (differentiated by native & exotic vegetation)
		Spatial distribution / continuity of fuel types
	Hillslope erosional processes	Changes in slope profile in relation to benchmark
		Rate of slope retreat in relation to benchmark
	Extreme climatic events	Total daily precipitation
		Frequency, magnitude, and duration of precipitation events
		Frequency, magnitude, duration, and directionality of wind events
		Continuous stream flow / discharge (cfs or cms); flow events described by magnitude, frequency, timing, duration, and rate of change
		Distribution / extent and abundance of standing dead trees in woodland / forest ecosystems

Table 1 continued.

Vital-sign category		VITAL SIGNS	Sample measures (measures vary in degree of specificity; those with potential applicability to multiple vital signs are indicated in bold type)
Ecosystem characteristics			
Disturbance regimes		Extreme climatic events	Distribution / extent and abundance of diseased / stressed trees in woodland / forest ecosystems
		Insect / disease outbreaks in forests and woodlands	Distribution / extent and abundance of standing dead trees in woodland / forest ecosystems
			Distribution / extent and abundance of diseased / stressed trees in woodland / forest ecosystems
Biotic integrity	Predominant plant communities	Status of predominant upland plant communities (particular communities of interest may vary among parks in relation to values, threats, and probability / consequences of change)	Composition and structure of predominant upland plant communities
	At-risk species or communities	Status of at-risk species – amphibian populations	Proportion of area occupied (PAO)
			Frequency of malformations
		Status of at-risk species – bat populations	Trends in key population parameters (e.g., colony size)
		Status of at-risk species – Mexican spotted owl populations	Territory occupancy
			Productivity
		Status of at-risk species – peregrine falcon populations	Territory occupancy
			Productivity
		Status of at-risk species – other TES vertebrate populations (species vary by park)	Potential measures vary by species
		Status of at-risk species – TES plant populations (species vary by park)	Potential measures vary by species
		Status of at-risk communities – riparian-obligate birds	Abundance and diversity of riparian-obligate birds
		Status of at-risk communities – sagebrush-obligate birds	Abundance and diversity of sagebrush-obligate birds
		Status of at-risk communities – pinyon-juniper-obligate birds	Abundance and diversity of pinyon-juniper obligate birds
		Status of at-risk communities – native fish communities	Abundance and diversity of native fish communities

Table 1 continued.

Vital-sign category		VITAL SIGNS	Sample measures (measures vary in degree of specificity; those with potential applicability to multiple vital signs are indicated in bold type)
Ecosystem characteristics			
Biotic integrity	At-risk species or communities	Status of at-risk communities – native grassland / meadow plant communities	Composition and structure of grassland / meadow plant communities
		Status of at-risk communities – sagebrush shrubland / shrubsteppe plant communities	Composition and structure of sagebrush shrubland / shrubsteppe plant communities
		Status of at-risk / focal communities – riparian / wetland plant communities	Composition, structure, and vigor of riparian / wetland plant communities
	Focal species or communities		Areal extent of riparian / wetland vegetation
		Status of focal communities – biological soil crusts	Composition and structure of biological soil crust communities (by morphological group)
		Status of focal communities – aquatic macroinvertebrates	Abundance and diversity of aquatic macroinvertebrates by functional group
		Status of focal / unique communities – spring, seep, & hanging-garden communities	Areal extent of groundwater-dependent vegetation
	Endemic species or unique communities		Abundance and diversity of obligate taxa
		Status of rare / endemic plant populations (species vary by park)	Potential measures may vary by species
		Status of other unique communities (communities vary by park)	Potential measures may vary by type of community
Landscape-level patterns	Land cover		Number, areal extent, and relative proportions of land-cover (ecosystem) types on park lands
			Spatial distribution and configuration of land-cover types on park lands
			Number, areal extent, and relative proportions of land-cover types on adjacent lands
			Spatial distribution and configuration of land-cover types on adjacent lands
	Land use		Number, areal extent, and relative proportions of land-use types on park lands
			Spatial distribution and configuration of land-use types on park lands
			Number, areal extent, and relative proportions of land-use types on adjacent lands
			Spatial distribution and configuration of land-use types on adjacent lands
	Land condition		Areal extent and relative proportions of park lands in different ecosystem-condition classes (defined by degree of departure from desired condition)
			Spatial distribution and configuration of ecosystem patches on park lands classified by ecosystem condition
			Areal extent and relative proportions of adjacent lands in different ecosystem-condition classes

Table 1 continued.

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Vital-sign category	VITAL SIGNS	Sample measures (measures vary in degree of specificity; those with potential applicability to multiple vital signs are indicated in bold type)
Ecosystem characteristics		
Landscape-level patterns	Land condition	Spatial distribution and configuration of ecosystem patches on adjacent lands classified by ecosystem condition
	Park insularization	Cross-boundary contrast between park lands and adjacent lands on basis of land cover, land use, and/or ecosystem condition
	Landscape fragmentation and connectivity	Spatial distribution and configuration of land-cover types on park lands
		Spatial distribution and configuration of land-cover types on adjacent lands
		Patch-size distribution of different land-cover types on park lands
		Patch-size distribution of different land-cover types on adjacent lands
		Movement / habitat-use patterns of large ungulates on park and adjacent lands
		Movement / habitat-use patterns of mountain lions on park and adjacent lands
Other vital-sign categories		
Stressors	Park use by visitors	Terrestrial visitor-use days by location, month, and type of activity
		Watercraft-use days by month and type of watercraft
		Park visitation by month (total no. of visitors)
		Frequency, location and nature of reported human-wildlife interactions
	Invasive exotic plants	Distribution and abundance of exotic plants by species
		Age- or size-class structure of exotic woody species
	Invasive, exotic, and/or feral animals	Distribution and abundance of feral animals
		Distribution and abundance of brown-headed cowbirds
		Distribution and abundance of exotic amphibians (e.g., bullfrogs)
		Distribution and abundance of exotic fish populations
		Distribution and abundance of exotic macroinvertebrate populations
	Occurrence patterns of novel diseases / pathogens	Frequency and extent of occurrence within surrounding region, by type (e.g., chronic wasting disease, West Nile virus)
	Permitted consumptive / extractive activities on park lands	Location, timing / duration, and intensity of permitted livestock use (e.g., AUMs)
		Location, type, and condition of livestock-related infrastructural developments
		Other permitted extractive uses – location, timing, and type of activity
	Park administration and operations	Location, timing, and type of weed-control activities
		Location, timing, and type of infrastructural maintenance activities (including roads and trails) by NPS and other permitted entitees
		Location, timing, and type of new infrastructural development by NPS and other permitted entitees
	Changes in stream hydrologic regimes due to surface-water diversions	Upstream and downstream density of water diversions
		Permitted water withdrawals from upstream and downstream water diversions (equate to flow reduction)
		Calls from downstream senior water rights owners

Table 1 continued.

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Other vital-sign categories		
Stressors	Changes in stream hydrologic regimes due to surface-water diversions	Changes in type of water right (e.g., diversion vs. storage)
		Changes in points of diversion for permitted water withdrawals
		Changes in types of beneficial use (e.g., irrigation, municipal, domestic, wildlife)
		Small impoundments in watershed (no. of acres)
	Changes in stream hydrologic regimes due to large reservoirs	Downstream and upstream distance of dams
		Hydropower calls
		River regulation / reservoir operation
	Changes in groundwater hydrologic regimes due to groundwater extraction	Amount of groundwater extracted in watershed
	Adjacent / upstream land-use activities	Logging activities on adjacent lands (within park watershed) – location / extent, timing, and type of operation
		Livestock grazing activities on adjacent lands – location / extent, timing / duration, and intensity (e.g., AUMs)
		Spatial distribution and density of vehicular disturbances on adjacent lands
		Pesticide applications – frequency and timing of occurrence within park airsheds and watersheds by type and quantity of compound
		Geophysical / mineral exploration and development on adjacent lands – location / extent, timing and type of operation
	Non-compliant uses on park lands	Location, timing / duration, and intensity of unpermitted (trespass) livestock use
		Frequency and total no. of cases of resource theft, poaching, and/or vandalism
		Other non-compliant uses – frequency, location, timing / duration, and type of activity
Other natural resource values	Status of paleontological resources	Spatial distribution and density of social trails in relation to exposures of fossil-bearing substrates
		Spatial distribution and density of vehicular disturbances in relation to exposures of fossil-bearing substrates
		Relative condition of individual fossil-resource sites, defined on basis of natural and anthropogenic risk factors
		Rates of fossil loss and exposure by erosion on fossil-bearing substrates
	Status of natural night skies	Night sky brightness
	Status of natural soundscapes	Sound levels (in dB) by frequency
		Sound sources (recorded audibility data)

Table 1 cont.

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Stressors	Park use by visitors	Terrestrial visitor-use days by location, month, and type of activity
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	Permitted consumptive / extractive activities on park lands	Location, timing / duration, and intensity of permitted livestock use (e.g., AUMs)
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